WHAT IS CLAIMED IS:

1. A method of modeling flame propagation comprising:

defining a flame surface area density of a flame as a flame surface area per unit volume of the flame;

expressing flame progress as generation of the flame surface area density in terms of at least one of a turbulent combustion and a laminar combustion;

determining flame growth resulting from turbulent combustion as being inversely proportional to a chemical reaction characteristic time and as a function of a turbulent Reynolds number; and

modeling the flame propagation based on the flame growth.

2. The flame propagation modeling method as recited in claim 1, further comprising

determining the flame growth resulting from laminar combustion as being proportional to both a laminar flame speed and to a ratio of a temperature of a burned portion to a temperature of an unburned portion and as a function of the Karlowitz number.

3. The flame propagation modeling method as recited in claim 1, wherein

the generation of the flame surface area density is expressed as a combination of the turbulent combustion and the laminar combustion.

4. The flame propagation modeling method as recited in claim 1, wherein

the flame growth resulting from the turbulent combustion is calculated based on the flame growth being inversely proportional to the chemical reaction characteristic time and proportional to both the turbulent Reynolds number raised to an exponential power and a stretch rate of the flame.

5. The flame propagation modeling method as recited in claim 2, wherein

the flame generation is further expressed as transport of the flame surface area density, which is expressed in terms of flame growth resulting from turbulent combustion and flame growth resulting from laminar combustion; and

the flame growth resulting from laminar combustion being expressed as proportional to the laminar flame speed, to the ratio of the temperature of a burned portion to the temperature of an unburned portion, and to an exponential function of the Karlowitz number.

6. The flame propagation modeling method as recited in claim 5, wherein

the exponential function of the Karlowitz number is the base of the natural logarithm raised to the power of the Karlowitz number.

7. The flame propagation modeling method as recited in claim 1, wherein

the flame growth resulting from the turbulent combustion is expressed as follows:

$$S_T = \alpha_1 (Re_t)^{\alpha_2}\, \Gamma \frac{\varepsilon}{\kappa}\, \Sigma,$$

where S_T represents flame growth resulting from turbulent combustion, Σ represents flame surface area density, k represents turbulence strength, ε represents turbulence dissipation rate, Re_t represents turbulent Reynolds number, Γ represents flame stretch rate, and α_1 and α_2 are model constants.

8. The flame propagation modeling method as recited in claim 2, wherein

the flame growth resulting from the laminar combustion is expressed as follows:

$$S_L = \beta_1 \exp(-\beta_2 Ka) \frac{T_b}{T_u}\, U_L \Sigma^2,$$

where S_L flame growth resulting from laminar combustion, Σ represents flame surface area density, U_L represents laminar flame speed, T_b represents burned gas temperature, T_u represents unburned gas temperature, Ka represents Karlowitz number, and β_1 and β_2 are model constants.

9. The flame propagation modeling method as recited in claim 1, wherein

the flame generation is further expressed as transport of the flame surface area density, which is expressed in terms of flame growth resulting from turbulent combustion and flame growth resulting from laminar combustion; and

the flame generation is suppressed by a resistance force imposed by air.

10. The flame propagation modeling method as recited in claim 1, wherein transport, generation, and diffusion of the flame surface area density are expressed as follows:

$$\frac{\partial \Sigma}{\partial t} + \frac{\partial u_i \Sigma}{\partial x_i} = \frac{\partial}{\partial x_i}\left(\frac{\nu_t}{\sigma_c}\frac{\partial \Sigma}{\partial x_i}\right) + \alpha_1 (Re_t)^{\alpha_2}\, \Gamma \frac{\varepsilon}{\kappa} \Sigma + \beta_1\, exp(-\beta_2 Ka) \frac{T_b}{T_u} U_L \Sigma^2 - D,$$

where Σ represents flame surface area density, k represents turbulence strength, ε represents turbulence dissipation rate, Re_t represents turbulent Reynolds number, Γ represents flame stretch rate, U_L represents laminar flame speed, T_b represents burned gas temperature, T_u represents unburned gas temperature, Ka represents Karlowitz number, ν_t represents turbulent kinematic viscosity, σ_c represents turbulent Schmidt number, D represents air resistance force, and α_1, α_2, β_1 and β_2 are model constants.

11. A method of modeling flame propagation comprising:

defining a flame surface area density of a flame as a flame surface area per unit volume of the flame;

expressing flame progress as generation of the flame surface area density in terms of at least one of a turbulent combustion and a laminar combustion;

determining flame growth resulting from laminar combustion as being proportional to both a laminar flame speed and to a ratio of a temperature of a burned portion to a temperature of an unburned portion and as a function of the Karlowitz number; and

modeling the flame propagation based on the flame growth.

12. The flame propagation modeling method as recited in claim 11, wherein the generation of the flame surface area density is expressed as a combination of the turbulent combustion and the laminar combustion.

13. The flame propagation modeling method as recited in claim 12, further comprising

determining flame growth resulting from the turbulent combustion is calculated based on a flame growth being inversely proportional to a chemical reaction characteristic time and proportional to both a turbulent Reynolds number raised to an exponential power and a stretch rate of the flame.

14. The flame propagation modeling method as recited in claim 11, wherein the flame generation is further expressed as transport of the flame surface area density, which is expressed in terms of flame growth resulting from turbulent combustion and flame growth resulting from laminar combustion; and

the flame growth resulting from laminar combustion being expressed as proportional to the laminar flame speed, to the ratio of the temperature of a burned portion to the temperature of an unburned portion, and to an exponential function of the Karlowitz number.

15. The flame propagation modeling method as recited in claim 14, wherein the exponential function of the Karlowitz number is the base of the natural logarithm raised to the power of the Karlowitz number.

16. The flame propagation modeling method as recited in claim 13, wherein the flame growth resulting from the turbulent combustion is expressed as follows:

$$S_T = \alpha_1 (Re_t)^{\alpha_2} \Gamma \frac{\varepsilon}{\kappa} \Sigma,$$

where S_T represents flame growth resulting from turbulent combustion, Σ represents flame surface area density, k represents turbulence strength, ε represents turbulence dissipation rate, Re_t represents turbulent Reynolds number, Γ represents flame stretch rate, and α_1 and α_2 are model constants.

17. The flame propagation modeling method as recited in claim 16, wherein the flame growth resulting from the laminar combustion is expressed as follows:

$$S_L = \beta_1 \exp(- \beta_2 Ka) \frac{T_b}{T_u} U_L \Sigma^2,$$

where S_L flame growth resulting from laminar combustion, Σ represents flame surface area density, U_L represents laminar flame speed, T_b represents burned gas temperature, T_u represents unburned gas temperature, Ka represents Karlowitz number, and β_1 and β_2 are model constants.

18. The flame propagation modeling method as recited in claim 11, wherein the flame growth resulting from the laminar combustion is expressed as follows:

$$S_L = \beta_1 \exp(-\beta_2 Ka) \frac{T_b}{T_u} U_L \Sigma^2,$$

where S_L flame growth resulting from laminar combustion, Σ represents flame surface area density, U_L represents laminar flame speed, T_b represents burned gas temperature, T_u represents unburned gas temperature, Ka represents Karlowitz number, and β_1 and β_2 are model constants.

19. The flame propagation modeling method as recited in claim 11, wherein the flame generation is further expressed as transport of the flame surface area density, which is expressed in terms of flame growth resulting from turbulent combustion and flame growth resulting from laminar combustion; and

the flame generation is suppressed by a resistance force imposed by air.

20. The flame propagation modeling method as recited in claim 11, wherein transport, generation, and diffusion of the flame surface area density are expressed as follows:

$$\frac{\partial \Sigma}{\partial t} + \frac{\partial u_i \Sigma}{\partial x_i} = \frac{\partial}{\partial x_i}\left(\frac{\nu_t}{\sigma_c}\frac{\partial \Sigma}{\partial x_i}\right) + \alpha_1 (Re_t)^{\alpha_2} \Gamma \frac{\varepsilon}{\kappa} \Sigma + \beta_1 \exp(-\beta_2 Ka) \frac{T_b}{T_u} U_L \Sigma^2 - D,$$

where Σ represents flame surface area density, k represents turbulence strength, ε represents turbulence dissipation rate, Re_t represents turbulent Reynolds number, Γ represents flame stretch rate, U_L represents laminar flame speed, T_b represents burned gas temperature, T_u represents unburned gas temperature, Ka represents Karlowitz number, ν_t represents turbulent kinematic viscosity, σ_c represents turbulent Schmidt number, D represents air resistance force, and α_1, α_2, β_1 and β_2 are model constants.